

## Addiction to the 3-dimensional Internet: Estimated prevalence and relationship to real world addictions

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(Received 16 December 2009; revised 25 July 2010; accepted 29 September 2010)

This study examined the prevalence of addiction to Second Life, the most prominent 3D virtual world, and found that approximately one-third of participants met criterion for Internet addiction or at-risk status on the internet addiction test (Young, K. (1998a). *Caught in the net: How to recognize the signs of Internet Addiction and a winning strategy for recovery*. New York, NY: John Wiley and Sons, Inc). Participants with higher levels of addiction were more likely to have resided in Second Life for a shorter period of time than non-compulsive users, stay logged on for lengthy periods of time, view sexual experience in Second Life as an important activity, and report experiencing stronger immersion and more benefits from using Second Life. In addition, moderate positive correlations were found between addiction to Second Life and various areas of compulsion in real life. These data provide the first assessment of the prevalence of addiction to the emerging 3D internet and serve as an empirical baseline as the number of users and graphical realism of 3D virtual worlds continues to grow.

**Keywords:** Internet addiction, 3-dimensional internet, prevalence, co-morbidity, immersive internet

### INTRODUCTION

#### Internet addiction: An overview

Since the Internet became a feature of mass culture in the mid-1990s, it has emerged as a major channel of communication for business, education, entertainment, and social interaction. Accompanying this expanding role in contemporary society, concerns have been

expressed about the potential for problematic levels of Internet usage. Some authors have suggested that as access to the Internet continues to expand globally, it may become the most serious behavioral addiction of our time (Byun et al., 2009).

A variety of terms have been used to reflect detrimental levels of Internet use, including: Internet addiction, Internet addiction disorder, online addiction, Net addiction, pathological Internet use, and Internet dependency (Davis, Flett, & Besser, 2002; Hur, 2006). Among these terms, “Internet addiction” is the most commonly used, in part because it is widely speculated that, like substance abuse, heightened Internet use is associated with a dopaminergic surge in the brain (Aboujaoude, Koran, Gamel, Large, & Serpe, 2006). However, the absence of neurobiological studies providing evidence of biochemical changes associated with problematic Internet use has caused some researchers and clinicians to question the appropriateness of this terminology and to advocate for describing the problem in more behavioral terms such as “compulsive computer use” (Liu & Potenza, 2007).

While controversy exists regarding terminology, there is broad consensus regarding the symptom pattern of the disorder. Young (1998b) identified eight symptoms of Internet addiction based upon the criteria for pathological gambling set forth in diagnostic and statistical manual of mental disorder (DSM-IV): cognitive preoccupation with the Internet, increased tolerance (i.e., need to spend more time online to derive the same level of satisfaction), unsuccessful attempts to decrease use, withdrawal symptoms when access is denied, staying online much longer than needed, secretive behavior or lying about online activity, negative emotional or practical consequences as a result of online activity, and use of the Internet to self-medicate (i.e., to reduce depression or negative mood

states). Shapira et al. (2003) has also proposed a general definition of Internet addiction that involves one symptom (an inability to control Internet use) and two signs (feelings of distress and impairment of daily activities).

### **Estimated prevalence and co-morbidity with real life addictions**

A number of studies have been conducted to estimate the prevalence of Internet addiction. Most of these studies have used either Young's (1998b) eight-item Internet addiction Diagnostic Questionnaire (DQ) or the more extensive Internet Addiction Test (IAT; Young, 1998a) to assess compulsive involvement in Internet activities such as surfing, chatting, gaming, and participation in social networking sites. Because these studies have evaluated Internet users in different age groups (adolescents, college students, and adults) and geographical settings (the United States, Scandinavia, Middle East, and Asia), it is not possible to cite a single, precise estimate of prevalence. Nevertheless, some general conclusions regarding prevalence can be drawn from this body of study. First, prevalence rates for Internet addiction tend to be about 1% for adult Internet users with another 5% of adults having usage levels that place them at risk for later addiction, as indicated by Aboujaoude et al. (2006) using several DSM-based diagnostic criteria and Bakken, Wenzel, Gotestam, Johansson, and Oren (2003) using Young's DQ. Second, prevalence rates for Internet addiction are consistently higher for younger users with the bulk of studies reporting that 2–4% of adolescent and college students meet criterion for Internet addiction on the IAT or DQ (Cao & Su, 2007; Ghassemzahah, Shahrray, & Moradi, 2008; Johansson & Gotestam, 2004; Kim et al., 2006; Whang, Lee, & Chang, 2003) with another 9–30% falling in the at-risk category. However, while these figures represent the most common estimates for Internet addiction among populations of youth, there are several studies which have reported substantially higher rates of Internet addiction for adolescents and young adults in Taiwan and China – the two countries, along with South Korea, reported to have the highest levels of Internet use. Specifically, Chou and Hsiao (2002) found that 5.9% of Taiwanese college students met criteria for Internet addiction while Wu and Zhu (2004) identified 6.4% of Chinese college students as Internet addicts. Across the seven studies cited, the average prevalence rate for Internet addiction among high school and college students was 3.6%. Three of these studies (Ghassemzahah et al., 2008; Johansson & Gotestam, 2004; Whang et al., 2003) also reported prevalence rates for moderate or at-risk levels of Internet usage, with an average estimate of 19.1%.

Compounding the problem of high prevalence rates are reports that individuals who exhibit compulsive patterns of Internet use often meet diagnostic criteria for various real world addictions including substance

abuse, pathological gambling, and compulsive buying (Black, Belsare, & Schlosser, 1999; Shapira, Goldsmith, Keck, Khosla, & McElroy, 2000; Shaw & Black, 2008). Thus, prior research on Internet addiction supports clinical observations of “cross-addictions,” or the common tendency for several addictions to co-occur in the same individual (Gossop, 2001; Haylett, Stephenson, & Lefever, 2004).

### **Addiction to the 3D or immersive Internet**

While existing prevalence rates for Internet addiction and indications of co-morbidity with real world addictions are alarming, recent dramatic changes in the Internet have heightened concerns over its potential to foster addictive use. During the past several years, a new phase or “iteration” of the Internet has been emerging which has been variously labeled as Web 3.0, Web 3D, or the immersive Internet (Driver & Driver, 2008). In earlier phases of the Internet, the emphasis was on digitizing and displaying the world's information on a vast array of web sites (Web 1.0 or The Informational Web) and promoting user interaction *via* chat rooms, wikis, and social networking sites (Web 2.0 or the Interactive Web). In contrast, in Web 3.0, the entire 3D world is being digitized and placed on the Internet. In this new world, 3D graphical environments serve as interactive spaces where users, in the form of avatars (3D digital representations of the self) can work, learn, and engage in social interaction. The assumed power of the immersive experience at the center of Web 3.0 applications has led to concerns that these environments could serve as even more potent sources of compulsive involvement than earlier versions of the Internet. Consistent with these concerns, there have been brief reports of individuals consumed with 3D Massively Multiplayer Online Role-Playing Games (MMORPGs) such as World of Warcraft and Lineage experiencing seizures or cardio-pulmonary failure as a result of being unable to log off (Choi, 2007; Chuang, 2006).

Despite these concerns, the extent of addiction to 3D virtual environments, in particular advanced 3D virtual worlds such as Instant Messaging Virtual Universe (IMVU), Entropia Universe, and Second Life, has not been systematically investigated. While all of these worlds enable users to employ downloadable software to create avatars (3D digital representations of the self) and engage in a variety of social, creative, and educational activities, Second Life is by far the largest and most populated virtual world. Thus, a convenience sample was recruited to assess possible problematic involvement with the immersive Internet. As this is the first assessment conducted in this area, it is by nature exploratory. However, based upon the characteristics of advanced virtual worlds and previous study on excessive use of non-immersive Internet applications, several specific predictions can be evaluated. First, due to the assumed power of the immersive experience, it is predicted that the prevalence of addiction to Second

Life will exceed estimates of over-involvement with other forms of Internet activity. Second, it is predicted that the level of addiction to Second Life will increase as a function of participant's level of integration and positive experiences within the virtual environment. Finally, consistent with prior data on Internet addiction, it is predicted that there will be substantial co-morbidity between high levels of addiction to Second Life and various areas of real life addiction such as alcohol, recreational drugs, shopping, gambling, food binging, and sex. Examining these issues will provide initial information on the extent of excessive involvement with 3D digital environments and identify major correlates of heightened use of the immersive Internet in the real and virtual realms.

## METHODS

This research was conducted with approval from Loyola Marymount University's Institutional Review Board.

### Participants

Two hundred and thirteen participants, all of whom had avatars in Second Life, were included in the study. One hundred and twenty-five participants (59%) were between the ages of 18 and 29, 39 (18%) were aged 30–39, and 26 (12%) were aged 40–49. The remaining 11% of the sample ( $n=23$ ) consisted of participants who were 50 years of age and older. Sixty per cent ( $n=128$ ) were females, 38% ( $n=80$ ) were males, and five participants (2%) identified themselves as transgender. While this was a convenience sample (see recruitment method in "Procedures and measures" section), the sample closely matched previous research regarding the demographics of Second Life users. For instance, Linden (2008) found that 60% of Second Life users were between 18 and 34 years of age and a survey by Market Truths (2009) found that over half of Second Life users were female.

### Procedures and measures

Participants were recruited via posted announcements in the Second Life Events Calendar, notices sent out by heads of large groups representing major constituencies in Second Life (e.g., social, business, educational, and artist networks), a CNN IReport ([www.ireport.com](http://www.ireport.com), a website where citizen journalists can post stories), and word-of-mouth communication during a 1-week period in February of 2009. Each method of recruitment offered potential participants the opportunity to come to a virtual research lab located within Second Life and earn 1000 Lindens (virtual currency equivalent to slightly less than four US dollars) for completing approximately 60 min of measures regarding "the psychology of Second Life." The recruitment notices also specified that the subject's avatar must have had at least 6 months residency in Second Life. This "minimal residency requirement" ensured that all data were

derived from at least moderately experienced users as opposed to newcomers with unstable patterns of behavior and use of the virtual environment.

Upon arriving at the virtual lab, participants were screened to ensure that they met the 6-month residency criterion and had never taken the Second Life addiction survey before. No participants were excluded because they had previously completed the Second Life addiction survey and three were excluded because they failed to take note of the minimum residency requirement emphasized in the recruitment notice. Participants who met the screening criteria and clicked their agreement to provisions of an informed consent form were then linked to an online survey website in order to complete the following measures. The online survey software Qualtrics was used to design the survey (<http://www.qualtrics.com>).

### *Real life demographic data*

Four questions assessed participant's real life age, sex, continent of residence, and highest level of education.

### *Basic Second Life data*

Participants were asked to report how long they had resided in Second Life (1 = <6 months, 2 = 6 months to 1 year, 3 = 1 to 2 years, 4 = 2 to 3 years, and 5 = >3 years), how often they logged on to Second Life (1 = <less than once a month, 2 = several times a month, 3 = weekly, 4 = several times a week, and 5 = daily/almost every day), and the typical duration of their in-world sessions (by estimating the approximate number of hours each session lasted). Participants rated the perceived importance of 11 Second Life activities (e.g., building/creating, shopping, sexual experience, etc.); each item was rated on a 5-point scale (1 = *not important at all* to 5 = *extremely important*).

### *The IAT, modified*

The IAT (Young, 1998a, 1998b) is a widely used measure of Internet addiction with strong internal consistency (Hardie & Tee, 2007; Widyanto & McMurrin, 2004) and some evidence supporting concurrent validity (Widyanto & McMurrin, 2004). It includes 20 items rated on a 5-point Likert scale that assess issues such as cognitive preoccupation and uncontrollable usage of the Internet, use of the Internet to cope with situational problems or reduce stress, withdrawal symptoms when access is denied, and detrimental effects on social adjustment and productivity in the non-digital world. Individuals who take the measure are classified as falling into one of four levels of cyber-addiction (from *none* to *severe*). In this study, the wording of items was adapted to reflect addiction to Second Life as opposed to general cyber-addiction. Thus, original items such as "How often do you find yourself anticipating when you will go on-line again" and "How often do you chose to spend more time on-line over going out with others?" were modified to read "How often do you find yourself anticipating

when you will go on Second Life again?" and "How often do you choose to spend more time in Second Life over going out with others?," etc.

Scores on the IAT generally range from 20 to 100 with higher scores representing higher levels of addictive or compulsive use of Second Life. According to Young (1998b), scores of 20–30 indicate normal or non-compulsive use, while scores of 31–49, 50–79, and 80 and above indicate *mild*, *moderate*, and *severe* levels of Internet dependence.

#### ***The Internet Behavior and Attitude Scale, modified***

The original Internet Behavior and Attitudes Scale (IBAS) was a 25-item measure that assessed "social aspects of Internet use and feelings of competency online" (Morahan-Martin & Schumacher, 2000, p. 17). On the original IBAS, six factors were identified which focused on positive feelings (e.g., ease of communication, confidence, and fun) and positive immersion (absorption, escape from real life pressures, and having a network of friends) associated with being online. Each item is scored on a 4-point scale from *strongly disagree* to *strongly agree*. The higher the score the greater the subject's reported level of positive experience and sense of immersion.

For the purposes of this study, 18 items pertaining to three factors of the original IBAS were selected: social confidence, social liberation, and competency. As with the IAT, the wording of items were adapted to reflect positive experiences specifically associated with being in Second Life. For example, the original items "When I am on-line I feel totally absorbed" and "Going on-line has made it easier to make friends" were modified to read: "When I am in Second Life I feel totally absorbed" and "Going on Second Life has made it easier to make friends," etc. From the original IBAS, one item from the social liberation factor was dropped, "I have pretended to be someone of the opposite sex while online;" and one item from the competency factor was dropped, "Going online has made it easier for me to do research."

#### **The Shorter PROMIS Questionnaire**

SPQ; PROMIS, patient reported outcomes measurement information system (Christo et al., 2003; Haylett et al., 2004). The SPQ consists of 16 subscales (10 items each) which assess potential addictive behaviors. Each subscale item is scored on a range of 0 (*not like me*) to 5 (*like me*) and each subscale results in a score ranging from 0 to 50. In this study, six subscales were examined: alcohol, recreational drugs, shopping, gambling, food bingeing, and sex, resulting in a 60-item questionnaire. Sample items include: "I think of buying things not so much as a means of providing necessities but more as a reward that I deserve for the stresses that I endure" (shopping subscale) and "I often drink significantly more alcohol than I intend to" (alcohol subscale). Scores for each subscale range from 0 to 50. Clinical cut-off scores were established using

the 90th percentile for each subscale as previously established by Christo et al. (2003).

Following completion of the measures, 1000 Lindens were transferred to the participant's Second Life account.

## **RESULTS**

### **Participant demographics and Second Life activities**

The vast majority of the sample reported living in either North America ( $n=155$ , 73%) or Europe ( $n=44$ , 20%). Relatively few subjects resided in South America ( $n=7$ , 3%), Asia ( $n=6$ , 3%), and Australia ( $n=3$ , 1%) and none of the participants came from Africa. With respect to education, 15 participants (7%) did not complete high school and 84 (39%) reported a high school diploma or GED as their highest level of education. Forty participants (22%) had completed a 2-year/Associates degree and 44 (21%) had earned a Bachelors degree. Seventeen (8%) of the participants had a Masters degree and six (3%) had a doctorate.

With regard to the length and extent of their participation in Second Life, 69 participants (32%) had been using Second Life for 6 months to a year; 86 (40%) had been on Second Life for 1 to 2 years, and 45 (21%) had been in-world for 2 to 3 years. Only 13 participants (6%) had been residents of Second Life for over 3 years. Almost all the participants were active users of the virtual environment, with 193 (91%) reporting that they logged on to Second Life on a consistent basis (i.e., daily, almost everyday, or several times a week). The remaining participants indicated they used Second Life on an intermittent or infrequent basis, with 14 (7%) indicating that they logged onto Second Life weekly and 6 (3%) indicating that they logged on either several times a month or less than once a month.

When they logged on to Second Life, 6 participants (3%) indicated that they typically stayed in-world for less than an hour, while 48 (23%) reported that they generally stayed in Second Life for 1–3 hours. Seventy-one (33%) said they typically stayed in-world for 4–6 hours and 47 (22%) usually stayed in Second Life for 7–9 hours. There were 18 participants (9%) whose typical session in Second Life lasted 10–12 hours and 23 (11%) of participants reported they regularly stayed in Second Life for over 12 hours at a time. During these in-world sessions, participants expressed a preference for certain activities. The following mean importance ratings for each activity (ranked from highest to lowest) were found: socializing ( $M=4.31$ ,  $SE=0.06$ ), exploring the virtual world ( $M=4.01$ ,  $SE=0.07$ ), shopping ( $M=3.79$ ,  $SE=0.08$ ), learning/education ( $M=3.65$ ,  $SE=0.08$ ), building virtual objects ( $M=3.52$ ,  $SE=0.09$ ), buying/selling ( $M=3.52$ ,  $SE=0.08$ ), finding/enhancing a relationship ( $M=3.34$ ,  $SE=0.09$ ), working/employment ( $M=3.20$ ,  $SE=0.09$ ), role playing/fantasy ( $M=3.08$ ,  $SE=0.10$ ), sex/sexual

experiences ( $M=3.02$ ,  $SE=0.10$ ), and scripting (i.e., writing computer code to animate objects) ( $M=2.71$ ,  $SE=0.09$ ).

#### Addiction to Second Life as assessed by the modified IAT: The relationship of IAT scores to real life demographic data and basic Second Life data

The average IAT score of this sample was 43.60 with  $SD=17.73$  ( $N=213$ ). The reliability of the modified-IAT within the present sample was high, Cronbach's  $\alpha=0.93$ , 95% CI [0.92, 0.95]. Figure 1 depicts the percentage of participants who fall into each of the four levels of Second Life dependence on the modified IAT, with approximately one-third of participants ( $n=71$ ) scoring in the severe or moderate categories of Internet addiction. None of the real life demographic variables significantly related to scores on the modified IAT (all  $ps > 0.14$ ).

Significant relationships were found between IAT dependence categories and basic Second Life variables. A one-way ANOVA tested the relationship between the IAT dependence categories and length of Second Life residence. Second Life residence showed a significant effect,  $F(3, 209)=3.05$ ,  $p=0.03$ , partial  $\eta=0.20$ . As tested by an exploratory contrast comparing normal and mild dependence to moderate and severe dependence, those with normal levels ( $M=3.08$ ,  $SE=0.13$ ) or mild levels of dependence ( $M=3.16$ ,  $SE=0.09$ ) spent more time on Second Life than those with moderate ( $M=2.76$ ,  $SE=0.11$ ) and severe dependence ( $M=2.78$ ,  $SE=0.29$ ),  $t(209)=2.04$ ,  $p=0.02$  (one-tailed),  $d=0.29$ .<sup>1</sup> (Readers are reminded that Second Life residence was measured with an interval variable where 1 = <6 months, 2 = 6 months to 1 year, 3 = 1 to 2 years, 4 = 2 to 3 years, and 5 = >3 years.) Thus, participants with more severe dependence have resided for *lesser* time in Second Life in comparison to those with no or mild dependence.

A significant one-way ANOVA was also found between the modified IAT dependence categories and frequency of Second Life log-ons,  $F(3, 209)=2.61$ ,  $p=0.05$ , partial  $\eta=0.19$ . (Frequency of log-ons was measured with an interval variable where 1 = <once a month, 2 = several times a month, 3 = weekly, 4 = several times a week, and 5 = daily/almost every day). An exploratory contrast showed a significant cubic pattern; those with normal ( $M=4.52$ ,  $SE=0.11$ ) and moderate levels of Second Life dependence ( $M=4.52$ ,  $SE=0.10$ ) logged-on less frequently than those with mild ( $M=4.80$ ,  $SE=0.09$ ) or severe dependence ( $M=4.90$ ,  $SE=0.25$ ),  $t(209)=2.63$ ,  $p=0.01$  (one-tailed),  $d=0.36$ . (Readers are reminded that frequency of log-ons was measured with an interval variable where 1 = <once a month, 2 = several times a month, 3 = weekly, 4 = several times a week, and 5 = daily/almost every day).

In addition, a significant one-way ANOVA was found between the modified IAT dependence

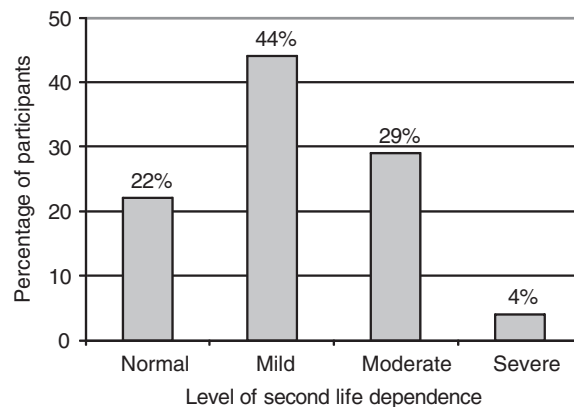


Figure 1. Percentage of participants ( $N=213$ ) across four levels of Second Life dependence as measured by the modified IAT.

categories and duration of in-world sessions,  $F(3, 209)=3.43$ ,  $p=0.02$ , partial  $\eta=0.22$ . An exploratory contrast showed a significant non-orthogonal pattern,  $t(209)=2.23$ ,  $p=0.02$  (one-tailed),  $d=0.31$ . Those with normal Second Life dependence ( $M=3.02$ ,  $SE=0.18$ ) had the lowest durations of in-world sessions, followed by those with mild levels of Second Life dependence ( $M=3.38$ ,  $SE=0.13$ ). Those with moderate ( $M=3.79$ ,  $SE=0.16$ ) and severe levels of Second Life dependence ( $M=3.67$ ,  $SE=0.43$ ) had the longest durations of in-world sessions.

Finally, a series of one-way ANOVAs tested the relationship between dependence levels (normal, mild, moderate, and severe) and importance ratings of 11 Second Life activities. There was a significant effect of importance ratings for sex/sexual experience and level of dependence,  $F(3, 207)=2.76$ ,  $p=0.04$ , partial  $\eta=0.20$ . As tested with exploratory contrast analysis, those with normal ( $M=2.94$ ,  $SD=1.58$ ) to mild dependence ( $M=2.79$ ,  $SD=1.33$ ) had significantly lower importance ratings of sex/sexual experience than those with moderate ( $M=3.39$ ,  $SD=1.23$ ) to severe dependence ( $M=3.44$ ,  $SD=1.42$ ),  $t(207)=2.04$ ,  $p=0.02$  (one-tailed),  $d=0.29$ .

#### Relationship between IAT scores and positive experiences and sense of immersion into Second Life

As mentioned, a modified IBAS (Morahan-Martin & Schumacher, 2000) assessed perceived benefits and positive immersion associated with being in Second Life. In this sample, the average IBAS score was 27.36 ( $SD=8.54$ ). The reliability of the modified IBAS was high, Cronbach's  $\alpha=0.91$ , 95% CI [0.89, 0.92].

A one-way ANOVA was conducted to evaluate the relationship between scores on the modified IBAS and Second Life dependence categories (as assessed by the modified IAT). A significant main effect was found,  $F(3, 208)=13.46$ ,  $p=0.00$ , partial  $\eta=0.40$ . As shown in Figure 2, a significant linear contrast was found,  $t(208)=5.02$ ,  $p<0.01$  (one-tailed),  $d=0.70$ .

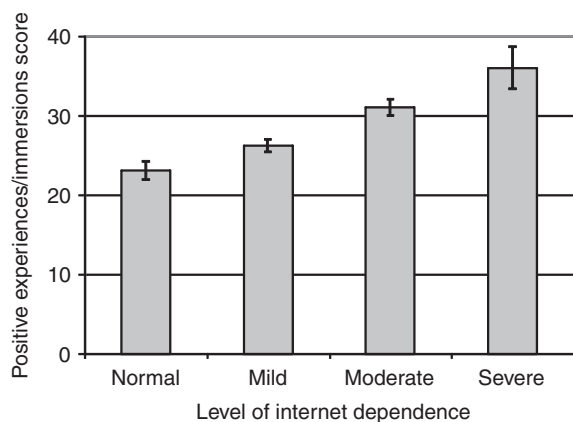


Figure 2. Positive experiences/immersion associated with Second Life as measured by the modified IBAS. Error bars refer to SEs.

Feelings of positive experiences/immersion increased as Second Life dependence level increased.

### Co-morbidity between immersive Internet addiction and real life addictions: The SPQ Subscales

The six subscales of the SPQ showed high reliability (mean Cronbach's  $\alpha = 0.94$ , range = 0.87–0.98). Table I presents the means and SDs for the subscale scores, as well as the percent of sample participants who would be labeled clinically addicted, based on norms established by Christo et al. (2003). (Table I results are listed in rank-order according to highest percent of clinically addicted to lowest percent clinically addicted.) Table I also reports the correlations between total IAT scores and PROMIS subscale scores; all correlations were significant.

To examine these patterns further, a series of one-way ANOVAs tested the relationship between level of Second Life dependence (as measured by the modified IAT) and PROMIS addiction scores. As shown in Table II, all six ANOVAs were highly significant ( $ps < 0.01$ ). Figure 3 shows each PROMIS subscale means according to levels of Second Life dependence.

Because of the significant ANOVA findings, a series of contrast analyses further tested these relationships based on the six means patterns displayed in Figure 3. The general pattern of results from contrast analyses confirmed the correlational results. Higher levels of Second Life addiction (i.e., moderate to severe levels) were significantly associated with higher levels of shopping, sex, food binging, gambling, drug, and alcohol addictions. Detailed results of the contrast analyses with the associated  $ts$  and contrast effect sizes are presented in the two right-most columns of Table II and in Figure 3.

## DISCUSSION

### Major findings

This study provides the first assessment of the prevalence of addiction to the emerging 3D Internet, in

Table I. PROMIS Subscale addiction scores, percentage of participants clinically addicted in each subscale, and correlations between PROMIS subscales and IAT.

PROMIS subscale	<i>M</i>	<i>SE</i>	% Clinically addicted	<i>r</i> with IAT
Shopping	15.71	0.74	24.40	0.34*
Sex	7.35	0.75	20.70	0.28*
Food binging	12.13	0.83	18.30	0.41*
Gambling	5.00	0.75	17.80	0.34*
Drugs	5.98	0.79	16.40	0.39*
Alcohol	10.70	0.82	4.20	0.35*

Notes: % clinically addicted was based on 90th percentile normative clinical cut-off scores established by Christo et al. (2003). All  $Ns = 213$ . IAT scores refer to a modified Internet addiction test (Young, 1998a).

\* $p < 0.01$ .

particular its most popular and complex site of Second Life. Using the IAT, the most widely used measure of cyber-addiction, it was found that approximately one third of adult users of Second Life met criterion for either severe (4.2%) or moderate/at-risk (29.1%), levels of Internet addiction while the remaining two-thirds of the sample demonstrated either mild levels of over-involvement or non-compulsive Internet use. These findings reflect prevalence rates that are approximately four times higher than those obtained in previous studies investigating Internet Addiction among adults using Web 1.0 or Web 2.0 (i.e., non-3D) applications (Aboujaoude et al., 2006; Bakken et al., 2003).

The estimated prevalence of addiction to the 3D virtual world by adult users is much closer to the average prevalence rates previously reported for Internet addiction and at-risk status among high school and college students for non-immersive web applications (i.e., 3.6% and 19.1%, respectively). This may reflect a general trend in which the extent of adult Internet use is converging with that of younger people and that previously reported age-effects are beginning to dissipate. It may also simply reflect the fact that almost 60% of this sample was in the 18–29 age brackets and thus, the age composition of the sample had a great deal of overlap with the prior, youth-oriented assessments of addiction to Web 1.0 and Web 2.0 applications. Nevertheless, even if these results are conservatively compared only to prevalence estimates among younger Internet users, they are still higher. If this difference is extrapolated to millions of Internet users worldwide who are currently participating in 3D virtual worlds, and millions more who will interact in these immersive settings in the future, the resulting numbers of individuals who will face issues of problematic usage of the 3D Internet could be substantial. In sum, these results provide preliminary support for expressed concerns that addiction levels would be higher for the 3D Internet than for Web 1.0 or

Table II. PROMIS subscale addiction scores according to level of Second Life dependence (based on modified IAT scores).

PROMIS subscale	Normal		Mild		Moderate		Severe		$F(3, 209)$	Partial $\eta$	$t_{\text{contrast}}$	$d_{\text{contrast}}$
	$M$	$SE$	$M$	$SE$	$M$	$SE$	$M$	$SE$				
Shopping	10.29	1.48	15.55	1.06	19.40	1.30	20.89	3.42	7.93*	0.32	3.84*	0.53
Sex	5.02	1.52	5.39	1.09	11.26	1.34	13.33	3.51	5.68*	0.27	3.38*	0.48
Food binging	5.92	1.60	10.45	1.15	18.26	1.41	20.67	3.70	13.77*	0.41	5.27*	0.73
Gambling	2.54	1.48	1.79	1.06	10.90	1.30	11.11	3.41	11.97*	0.38	4.15*	0.57
Drugs	3.31	1.54	2.67	1.10	11.05	1.35	19.78	3.56	13.71*	0.40	5.35*	0.74
Alcohol	6.94	1.64	8.35	1.17	16.34	1.44	16.44	3.79	8.96*	0.34	3.87*	0.54

Notes:  $F$ -scores and partial  $\eta$ s (effect sizes) results from one-way ANOVAs of PROMIS subscale addiction scores by level of Second Life dependence.  $t_{\text{contrast}}$  and  $d_{\text{contrast}}$  (effect size of contrast) refer to contrast analyses testing the mean patterns displayed in Figure 3.

\* $p < 0.01$ .

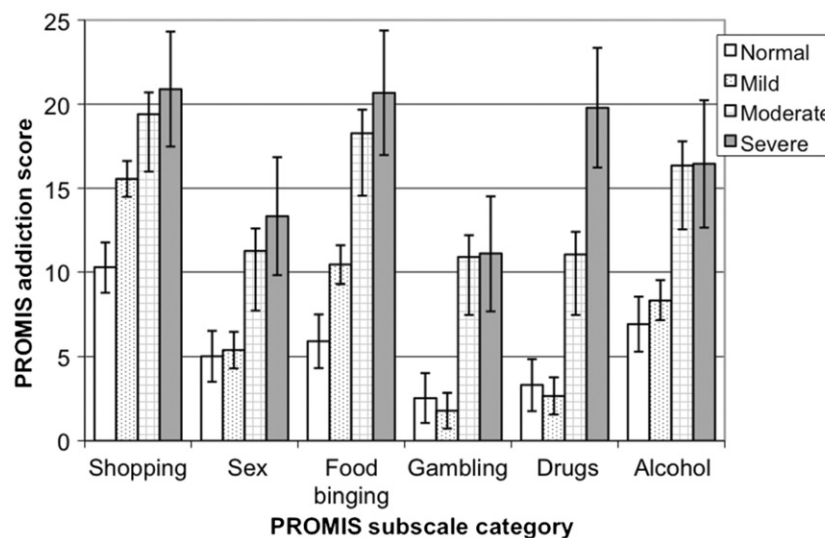


Figure 3. PROMIS subscale addiction scores by Second Life dependence as measured by the modified IAT. Error bars refer to  $SE$ s. Clinical cut-off scores for the addiction subscales are as follows (according to Christo et al., 2003): shopping = 25, sex = 16, food binging = 26, gambling = 8, drugs = 20, and alcohol = 34.

2.0 applications due to the power of the immersive experience. However, as has been done with Web 1.0 and 2.0, it is important that this initial estimate of prevalence is replicated with other samples to derive the most accurate and stable estimate of prevalence.

In addition to examining the overall prevalence of addiction to Second Life, the relationship between addiction scores and other forms of data were examined. No significant relationships were found between participant's scores on the modified IAT and any real life demographic variables (i.e., age, sex, location of physical residence, or level of education). However, there were several basic Second Life variables where significant relationships with participant's modified IAT scores were found.

The length of time participants had resided in Second Life was significantly related to their level of addiction. Participants in the at-risk and severe categories of dependence had resided in Second Life for

significantly *less* time in comparison to those with no or mild dependence. This pattern of results essentially replicates the findings of Young (1998b) in which the majority of Internet dependents had been online for less than one year whereas the majority of non-dependents had been online for more than a year. Based upon these findings, Young suggested that the IAT should be used cautiously with novice Internet users who often show an initial spike during their first 6 months of exposure. Following this guidance, participants in this study were required to have been in Second Life for at least 6 months to take part in the study. The incorporation of this minimum residency requirement was designed to exclude new users who may have been spending substantial time in the virtual world, not because of an addictive process, but because they were awestruck or dazzled by their initial experience of the 3D world and to focus the investigation on individuals who had moved beyond the initial novelty period and

established more stable reactions to the environment. Nevertheless, even excluding users with less than 6 months of experience in Second Life, addiction levels were still significantly lower among longer-term residents of the virtual world. Thus, the data suggest that problematic levels of involvement in immersive worlds are more likely to occur in the earlier phases of participation with addictive tendencies becoming less prominent among long-term, stable users of the 3D environment. At the same time, experience with other objects of addiction caution against concluding that excessive Internet involvement during an initial contact period will always be followed by adaptation.

The typical duration of participant's in-world sessions in Second Life also predicted moderate and severe levels of addiction. As users reported spending longer amounts of time online, the severity of addiction increased. Thus, the duration of in-world sessions appears to be an important correlate of addiction levels to Second Life. Previous research on non-immersive Web applications is consistent with this finding. A variety of studies have found that time spent online is a useful index of the level of preoccupation with Internet activities, with problematic users consistently spending significantly more time on the Internet (Ferraro, Caci, Amico, & Blasi, 2007; Ghassemzahah et al., 2008; Khazaal et al., 2008; Morahan-Martin & Schumacher, 2000; Yang, 2001).

Finally, with respect to basic Second Life variables, while the overall sample rated sex/sexual experience as the next to lowest in importance for eleven core activities, those participants who considered it important were more likely to have higher levels of Internet addiction. These findings suggest that virtual sexuality may be a motive for heightened involvement in immersive worlds for a subset of participants but not the general population of users.

In addition to these basic Second Life variables, participant's perceptions of immersion and positive benefits from using Second Life were associated with their level of addiction to the 3D virtual experience. On the modified IBAS, participants with moderate and severe dependence on Second Life experienced more positive feelings and a greater sense of psychological immersion when using Second Life. Users who were moderately or severely addicted were more likely to agree that they use Second Life to escape from real-life pressures, open up more to people on Second Life, are more comfortable when using Second Life, prefer communicating with Second Life friends, and share intimate secrets in Second Life. They also tended to indicate that they felt totally absorbed when on Second life, were more "themselves" in Second Life, had more fun with people from Second Life, and indicated their Second Life friends understood them better. Second Life seems to provide a unique set of benefits for those who meet criteria for addiction. These findings echo the conclusions of Young (1998a, 1998b) who also found that Internet dependents

reported that their Internet involvement was associated with a set of positive benefits in their lives, including allowing them to increase their circle of friends and enhance feelings of intimacy.

Finally, significant, moderate correlations were found between problematic levels of involvement with Second Life and all six areas of real-life compulsion assessed by the SPQ. These findings echo previous research on Web 1.0 and Web 2.0 applications, indicating that Internet addicts often meet diagnostic criteria for substance abuse, gambling, and compulsive buying (Black et al., 1999; Shapira et al., 2000; Shaw & Black, 2008). They are also consistent with clinical observations of "cross-addictions," or the common tendency for several addictions to co-occur in the same individual (Gossop, 2001; Haylett et al., 2004).

The co-variation between problematic Internet use and other forms of real-life compulsive behavior found in prior research and this study, raises questions regarding whether preoccupation with the Internet, including the immersive Internet, is best viewed as a distinct disorder or merely as a medium to gratify other addictions (Liu & Potenza, 2007; Schaffer, Hall, & Vander Bilt, 2000). For example, compulsive shoppers in real life may be drawn to an immersive environment such as Second Life, not because they are addicted to the 3D world *per se*, but because the high exchange rate of virtual currency to US dollars (fluctuating between 250 and 300 Lindens per dollar) provides them with significant purchasing power and allows them to be more active and extravagant shoppers in the virtual world than they can be in the real world. Similarly, individuals with real life sexual compulsions may spend considerable time in the virtual world because of the large number of potential sexual partners available in the virtual world. In both cases, the 3D world primarily serves as a mechanism for accessing rewarding and addictive content rather than an object of addiction *per se* and the individuals involved are probably best viewed as having a real-world impulse disorder expressed in an immersive context rather than a distinct addiction to the 3D Internet. However, it is difficult to extend this thinking to food bingeing, drug or alcohol abuse, or gambling because there is no consumption in the virtual world and gambling has been prohibited for several years. Thus, there are instances where the primary impetus for the individual to be drawn into the virtual world is the captivating experience of being in a 3D immersive setting rather than any particular compulsive activity also found in the real world. Under these circumstances, one could justifiably speak of a distinct, independent addiction to the immersive, virtual world.

In this study, separating addiction to the 3D Internet *per se* from use of the immersive environment to gratify other forms of addictive behavior is even more difficult. This is because the virtual world users who participated in the study reported higher rates of real

world addictions on all six PROMIS subscales than in a typical population. Specifically, Christo et al. (2003) used the 90th percentile as a clinical cut-off score, which by definition means that 10% of their sample met criterion for an addiction on each subscale. However, in this sample the per cent of participants who would be labeled clinically addicted, based on norms established by Christo et al. (2003), was substantially higher, in the 16 to 24% range. The only exception to this finding was on the alcohol abuse subscale where only about 4% of participants were above the clinical cut off. Subject to replication, these findings suggest that the high prevalence rates for severe and at-risk levels of Internet dependence may be due to more individuals with elevated addictive tendencies being active users of 3D virtual worlds as well as the captivating nature of the immersive environment itself.

### Methodological issues and limitations

In recent years, there has been increased recognition of the potential value of conducting scientific research within virtual worlds (Bainbridge, 2007; Slater et al., 2006). However, because research based in the 3D Internet is relatively new, methodological standards for conducting scientifically sound studies in immersive environments have yet to be established. Of particular importance is the lack of guidelines for obtaining a representative sample of participants within a virtual environment. In the absence of such standards, prior studies have tended to use informal and non-rigorous sampling methods such as directly soliciting participants in "popular and unpopular locations in Second Life" (Nood & Attema, 2006) or setting minimal criteria for research participation, such as being a resident for 30 days in Second Life and having payment information on file (<http://sl.market-truths.com/>).

In an effort to improve the methodology of virtual world research, this study employed a multi-method approach to sampling that involved posting announcements in various Second Life forums, sending out notices to a range of virtual world constituencies, networking through word-of-mouth communication, and offering a moderate financial inducement for participation through each channel. This approach was successful in quickly attracting potential participants. However, while this study represents progress in sampling methods in the fledgling area of virtual world research, the recruitment approach resulted in a convenience sample and is still limited by selection biases that affect all forms of on-line studies. On a positive note, the gender and age characteristics of the sample was similar to those found in larger demographic surveys of Second Life users (Linden, 2008; Market Truths, 2009), which provide some support for its representativeness with respect to the wider population of in-world residents.

### Conceptual issues and future considerations

Discussions of addiction to the 3D virtual world are complex because it can be argued that there is a fundamental difference between extremely high utilization of immersive 3D worlds and other forms of real life or cyber-addiction. Specifically, typical addictions involve activities that depart from normal life in *content* (e.g., drugs use or gambling) or *extent* (e.g., shopping compulsion or food binging). However in the 3D Internet, many of the primary activities that individuals engage in (e.g., work, forming friendships, or intimate relationships) are considered normal aspects of real life. In other words, participation in Web 3D involves an attraction to a different context for engaging in a set of behaviors identical to the ones practiced in daily life. From this perspective, high involvement in Second Life or other complex virtual worlds can be viewed not as an addiction or a compulsive problem, but as an "alternative realm" or cultural context to engage in normative activities of social interaction, learning, and work. Viewed in this light, high involvement in the virtual world is not a form of pathological escapism or addiction; it is literally a "second life."

In discussing this research with active users of the virtual world (both in pilot interviews and after the data were obtained), this schism between the "addiction model" of high utilization and the non-pathological "alternative realm model" was clearly present within the Second Life community. Many residents referred to high involvement users as being "addicted to Second Life" and encourage early detection and treatment just as one would find with other forms of real world and cyber-addiction. However, others balked at this notion and emphasized the alternative realm view of Second Life. They raised pointed questions such as: "If I go to work and earn money in Second Life for 9 hours a day am I an addict or have a pathological compulsion or do I merely have a second world in which to work?" or "If I have a relationship with someone in Second Life who I spend a lot of time with, am I an addict or am I just interacting with someone special in my life?" While proponents of the alternative realm model acknowledged that it is difficult or impossible to live two lives with equal fullness, and thus there were some detrimental real-life consequences to high levels of involvement in the 3D virtual world, they view this as a logistical problem (similar to the challenge of balancing work and relationships in real life) rather than as symptomatic of an addictive disorder. Moreover, these data indicating that addiction levels are lower among longer-term residents of Second Life are more in line with the alternative realm model. Specifically, because addictions are progressive disorders, one would expect their frequency and intensity to increase with time of usage rather than decline, as in this study, with longer exposure to the presumed addictive agent. Nevertheless, the ambiguity of how to

conceptualize high levels of involvement in immersive activities presents an ongoing challenge for the understanding of 3D virtual worlds in general, and especially with respect to determining the prevalence of addiction or problematic usage.

## CONCLUSION

In the past 2 years alone, the number of registered avatars in Second Life has expanded from 13 million to over 20 million, with proportionate growth in the size of the virtual world and the number of active participants. These metrics, and a variety of other across Second Life and other 3D virtual platforms, support the view that the rise of the immersive Internet reflects a new phase in the development and history of the Internet rather than something ephemeral or faddish. As these usage levels continue to grow, the nature of addiction to the immersive Internet will continue to be debated and evaluated. This study contributes to these considerations by providing initial empirical data on the prevalence of addiction to the 3D Internet and some of its major correlates both within and outside the virtual world. It is possible however, that the addictive qualities of the immersive Internet will not be fully realized until the graphical fidelity of 3D environments continues to increase and approaches photorealism. As a result, periodic reassessments of prevalence may be necessary as this rapidly advancing technology continues to evolve.

**Declaration of interest:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

## NOTE

1. Due to unequal *ns* between groups, the following formula was used to calculate contrast *ts*:

$$t = \frac{\sum \lambda_i M_i}{\sqrt{[\sum (\lambda_i^2 / n_i)] S^2}}$$

where  $\lambda_i$  = contrast weight for *i*th mean,  $M_i$  = mean of *i*th condition,  $n_i$  = sample size for *i*th condition, and  $S^2$  = *MS* error (Rosenthal & Rosnow, 1991).

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